

SUPPLEMENT.

The Mining Journal, RAILWAY AND COMMERCIAL GAZETTE:

FORMING A COMPLETE RECORD OF THE PROCEEDINGS OF ALL PUBLIC COMPANIES.

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Original Correspondence.

BIRMINGHAM AND THE BLACK COUNTRY—No. IV. THE MANUFACTURE OF IRON.

We have before intimated that the conversion of pig or cast-iron into wrought-iron depends almost solely and entirely upon the process of puddling. The invention of puddling is generally attributed to Henry Cort, and the process was patented by him in 1784. Although Cort was the first to thoroughly develop and introduce this process, it is clear the idea of treating iron in a similar manner had occurred to others. In 1766 Thomas and George Crangue were granted a patent for a process which was as near an approach as possible to puddling, if not the exact process itself in a rough form. The following extract is from their specification, and shows the mode of conducting their plan:—

"The pig-iron is put into a reverberatory or air-furnace, built of proper construction, and, without the addition of anything more than common raw pit coal, is converted into good malleable iron, and being taken red-hot from the reverberatory furnace to the forge-hammer is drawn into bars of various shapes and sizes, according to the will of the workman."

Whether this process was ever carried to any extent, as set forth, there is no evidence to prove; and yet it seems that they were acquainted with the matter practically, for on Cort calling at the Colebrookdale Ironworks to negotiate with the manager, Mr. Richard Reynolds, for working his (Cort's) patent puddling process upon royalty, he was taken into the works, where Thomas Crangue, by request, made a puddled ball. It is quite probable that the Messrs. Crangue did not know the value of their invention, or found it could not be worked to a profit. Again, we find that Peter Onions took out a patent in 1783 for a process which was literally puddling. His mode of operation was to heat the iron in a furnace, in which separate places were provided for the iron and the fuel; he also forced blast under the fire-grate, and upon the surface of the molten iron, and speaks of the iron being stirred about through an aperture in the door of his furnace until it came to nature, and could be drawn out and taken to the hammer. Notwithstanding the evidence we have of these patents existing prior to the one taken out by Cort, it is a fact that his was the only one to any extent developed and adopted, and it is without doubt the process now universally carried out in our ironworks, there having been few improvements since.

From Cort's specification we learn that he used a reverberatory or air furnace, in which the metal was fused in a separate apartment from the fuel, or either conveyed to the furnaces in a molten state. When the metal was put in the furnace the door was kept closed until the iron became sufficiently heated, and then the workman opened a small aperture in the bottom of the door, and through it, by means of an iron bar, moved about the metal. After the metal had been some time dissolved an effervescence took place, and the iron was then stirred, separated, and spread about by the workmen until it came to nature, when it was collected into loops or balls, and withdrawn to be taken to the hammer and rolls. Cort also invented grooved, or puddled, rolls, through which the blooms are drawn down into what are now called puddled bars. A bloom is a puddled ball, cleared of cinder, and worked into a shape under the hammer. It will be seen that Cort produced two of the greatest inventions connected with the manufacture of iron; yet he met the fate of too many distinguished scientific men, and died poor, although his patent was at one time estimated to be worth 250,000*l*. The injustice he received at the hands of the Government, and a detailed account of his misfortunes, will be found in the "Statement of the Claims of the Surviving Members of the Family of the late Henry Cort for National Compensation," or briefly in Dr. Percy's valuable work upon "Metallurgy." The two great improvements in the process of puddling since Cort's invention are the substitution of iron for sand bottoms in the puddling-furnace, and the introduction of the "pig-boiling" process. The former was invented by Samuel Baldwyn Rogers, of Nant-y-Glo, about the year 1818. The old sand bottoms were much wasted and destroyed by the conversion and manipulation of the iron, and consequently were continually getting out of repair, at the expense of a great deal of time and labour. The "pig-boiling" process was introduced by Mr. Joseph Hall, of the firm of Barrows and Hall, Bloomfield, near Dudley. The value of this process is that it saves a considerable amount of labour upon the old plan, and saves time by allowing a much greater quantity of iron to be operated upon.

The usual mode of manufacturing wrought-iron in South Staffordshire is as follows:—The bosh or shallow dish of the puddling-furnace in which the iron is worked is covered round its sides by pieces of bull-dog, or calcined tap-cinders; these are plastered over by the same substance ground to a powder, and brought to the consistency of paste; a coating of oxide of iron is supplied to the bottom of the furnace to prevent the iron undergoing conversion, burning and sticking to it. This coating is renewed every shift or turn of twelve hours, and is supplied by about 1 cwt. of scrap-iron, which is worked into a ball, withdrawn and rolled into a scrap bar. As soon as the puddler finds the oxide of iron in a fluid state he introduces his charge of pig-iron, about 4 cwt., and with it a quantity of hammer-slag and swarf. The furnace door is then securely closed, and a good fire kept up. When the puddler thinks the iron sufficiently hot he takes the stopper out of the hole at the bottom of the furnace door, and inserts a bar of iron, called a paddle, and with this he and his under-hand alternately move about the iron to prevent parts of it sticking to the bottom, and to expose the whole to the action of the flame passing over it. Upon the iron reaching the melted state the damper is let down, but if the furnace is what the puddlers call very cold, this is not necessary, as the iron will "come up" without. The iron is now thoroughly fused, and the puddler commences to turn and stir it about with his rabble until it swells and boils; then from its surface blue jets of flame are seen rising, spouting the iron about in sprays, showing that the oxygen in the swarf and fettling at the bottom and sides of the furnace, is doing its work of decarbonisation, assisted by the oxygen in the air passing with the flame over the top.

Upon the iron reaching this stage it begins to diminish in bulk, and comes to nature; portions of it can then be seen floating about in pasty masses amongst the fluid cinder; these are collected into balls, usually six in number, withdrawn one by one, and taken as quickly as possible—to prevent oxidation—to the hammer, where

they are shingled. The hammers commonly used for shingling are the helves or lift hammers; these have their fulcrum at one end, which is supported upon standards or carriages; the other end, or nose, is lifted by the arms of a cam-ring, and then dropped through a space of from 18 to 24 in. upon the hot iron. The hammer, let into the valve, and the anvil are close to the nose. In some places crocodile or rotary squeezers are used; but these are slow in their action, and do not eject the cinder near so well as a helve; they are calculated to press some of the cinder into the iron, and answer the purpose very well for soft common iron. Steam-hammers are now much used in the larger ironworks, and are very valuable, as the blow can be so nicely regulated. With the larger ones doubling can be practised—i.e., making a bloom of two or more puddled balls, to be used for plates and the larger descriptions of iron. When the puddled ball is shingled into an octagonal bar, it is passed through the puddle rolls, and drawn into a puddled bar; it is then allowed to get cold, and afterwards cut up by the shears into lengths, to be conveyed to the mill heating-furnaces, where it is piled, heated, and rolled out as finished iron into any required shape.

Space will not permit a description of the various mills and appliances connected therewith; but in future accounts of ironworks many of these will receive attention.

COLLIERIES IN NORTHUMBERLAND—THEIR WORKINGS AND MACHINERY.

The NETHERTON COAL COMPANY has two establishments for raising coal in operation, situated in the northern part of the steam coal district of Northumberland. These are the Frances pit and the Howard pit, the whole, both in the engineering and financial departments, being under the management of Mr. J. R. Liddell. The Five-quarter and Low Main seams are worked at these collieries, both of which produce steam coal of excellent quality. Coal had been worked on this property 60 years ago, to supply the towns of Morpeth and Blyth with house fuel, but only on a limited scale until the last 25 years. Mechanical appliances are brought into requisition to a great extent in the Netherton Mines for underground hauling, for draining dip workings, and for ventilation by a fan played on the surface. These are the prominent features at these works, and we are glad to notice all such improvements, tending to promote the safety of colliery operations, having at the same time economy of working in view.

The Frances pit is 13 feet in diameter, divided by wood brattice into two parts, one portion (4½ feet) being the pump shaft; the remainder is appropriated for coal work. This pit in the whole is downcast; the upcast is one of the Howard pits, about 800 yards distant, being an air-pit in connection with the fan erected near it. The winding-engine at the Frances pit is a 40-in. non-condensing lever engine, 6-ft. stroke, with two 11-ft. flat wire-rope drums; the drums and fly-wheel are supported intermediately by a framework of wood, and cast-iron column. About 650 tons of coal is raised per day in single-decked cages, two tubs in each; the contents of each tub vary from 8 to 11 cwt. of coal. This is raised from the level of the Five-quarter seam, 60 fathoms in depth. The same engine also pumps at night, raising the whole of the water made in the mines in two lifts. In this case the back lever projects over the cylinder, and to this the pumping beam is connected; the latter extends from the pit to a staple within the house. The lower lift (in the pit) is 39 fathoms, 17-in. bucket, 6-ft. stroke; the upper lift (in the staple) is 24 fathoms, 17-in. bucket, 6-ft. stroke. At the rate of 12 strokes per minute, 700 gallons of water should be raised. Five plain boilers supply this engine with steam, at 35 lbs. pressure; three are 34 by 6 ft., and two 34 by 5 ft.; these, with the boilers hereafter named, are all hand-fired. An engine for hauling underground is placed at the top of the pit; it has two 26-in. horizontal cylinders, 4½-ft. stroke, direct-acting, two drums 9 ft. in diameter for the main and tail hauling ropes; another flat-rope drum for winding in the pit at night, and a 3½ ton fly-wheel, are placed between the hauling drums. The drums are all on one shaft. The two hauling drums are put in or out of gear by clutches. This engine is supplied from five boilers, at 35 lbs. pressure; two are plain, 38 by 5 ft.; one plain, 34 by 4½ ft.; and two Lancashire boilers, 30 by 6½ ft. shell; 2 ft. 4 in. tubes. The hauling ropes from the engine are conveyed over two 10-ft. pulleys at the top of the pit, and two 6-ft. pulleys at the bottom; they are enclosed in wooden boxes in the pit.

The engine bank proceeds in a direction N. 66 E. from the pit bottom in the Five-quarter seam. The bank-head is 100 yards in length, the two bank-head roads dip in contrary ways for the empty and laden tubs. The following 300 yards dips at the rate of 4 inches per yard, being a cross-measure drift, which at the bottom joins the Low Main seam; the engine bank is afterwards continued in the Low Main, in which an extensive area of workings have been laid out, and are now being worked off homewards. On the dip of 300 yards the tubs run in by gravity, 26 at once, and the main rope only is used for drawing them out; beyond this both tail and main ropes are used, first in a direction N. 66 E., which is afterwards changed to N. 89 E. for a further distance of 900 yards, where the road undulates, being in parts nearly level, but usually dipping from 1 to 2 in. per yard. A fault, rising eastward 16 ft., is crossed in this distance. From the end of the dip of 300 yards, another plane 700 yards in length proceeds in a direction N. 18 E., also worked in and out by tail and main ropes; a distinct tail rope, disconnected as required, is used for the east plane, and another for the north plane. A station or stopping place is provided about midway in the 900 yards length, to which a set of empty tubs are run, and the full ones are taken away without any change of ropes. The extremity of the east plane is fed by a self-acting incline 300 yards in length, beyond that small ponies are used. The Low Main seam proves of unusual thickness in the line of the engine bank eastward, attaining a thickness of 9 feet in some parts, the general thickness, however, varies from 4 feet to 9 feet. Section taken on the north side of the engine bank is as follows:—

Metal roof—good.	
Bastard Canal	0 ft. 2 in.
Grey coal	0 ft. 8 in.
Good coal	2 7
Shale band	0 2
Good coal	1 7 = 5 0
Underlay.	

The measures are very variable in their dip, perhaps the most usual dip is eastward from 1 to 2 in. per yard. The cleavage runs N. 66 E.

or S. 66 W. in this seam. No fire-damp is emitted from the coal. Candles only are used in the workings; powder is generally used both in whole and pillar working. The only fatal accidents to men have been caused by falls of stone and coal, and on the engine-planes to boys as attendants; these, however, have been few in number. The Low Main seam is worked entirely on the bord and pillar system; the pillars are usually made 30 by 12 yards, the bords 5½ yards, and the walls 2½ yards in width; the pillars are worked off the entire breadth in one lift, from each end to the middle, or they are sometimes got by driving a 4-yard jeukin on one side of the pillar; the remaining 8 yards is then brought backward in one lift. A wind-dyke runs through this mine nearly east and west, and parallel with the lower part of the engine-plane. The vein of whin varies from 5 to 12 yards in thickness at the different points where it has been intersected; it is extremely hard; the coal seems to be charred slightly for 2 yards or more on each side of it; beyond this no alteration takes place in the quality of the coal on the respective sides, neither is there any difference in its level. Another whin-dyke, parallel to the former, runs through the property at a distance of 200 yards from it.

The drainage of the east district of workings is effected by a steam-engine placed 450 yards from the pit, on the side of the engine-plane; the steam is supplied from the surface boilers of the hauling-engine in 5-in. pipes. This pumping-engine has two 14-in. horizontal cylinders, 3-foot stroke, direct-acting; it works three lifts of pumps, which range from the east extremity of the engine bank to the pit, a length of 1320 yards, and of vertical lift 190 feet. Two of the lifts are below the engine, and are worked by one endless wire-rope, passing over four vertical wheels, 6 and 7 feet in diameter; to three of these grooved wood curbs are fixed to receive and grip the rope. The third lift is above the engine, and is worked direct from it. The first or bottom lift (85 ft. vertical) has two 7-in. ram-pumps, 3-ft. stroke, worked by cranks from the shaft of the lowest grooved wheel. The main pipes are 8-in. diameter, and 600 yards in length. The middle lift (25 ft.) has two 8-in. ram-pumps, 3-ft. stroke, 8-in. main pipes, 255 yards in length. The third lift (80 ft. above the engine) has one double-acting plunger, 8½ in. in diameter, 3-foot stroke, 8-in. main pipes, 460 yards in length. The engine goes at present 8 hours in 24, at the rate of 20 strokes per minute; at this speed the quantity of water delivered should be 300 gallons per minute. There is still a large margin for an increase in the flow of water. The pumps have delivered at former times as much as 450 gallons per minute.

About one-third of the coal supply to the Frances Pit is obtained by the engine bank; the remainder is brought from the district north-west of the pit over two self-acting inclines. A fault, rising northward 8 fms., is crossed near the pit; this throws up the Low Main on a level with the Five-quarter seam. By a stone drift, rising 6 in. per yard and 240 yards in length, the Five-quarter seam is again reached; this drift forms the first self-acting incline, leading near the shaft; beyond this another incline is formed in the seam, rising from 1 to 2 in. per yard, and 400 yards in length. The coal to these inclines is supplied principally by small ponies. The Five-quarter seam is worked extensively here. The section of this seam is—

Metal roof, inferior.	
Good coal, with 2 in. band in it	3 ft. 2 in.
Fire-clay, good	0 6
Coal	0 3
Band of shale	0 4
Coal	0 11 = 5 ft. 2 in.
Underlay, good.	

The upper coal, 3 ft. 2 in., only is taken in working this seam; the lower beds are valuable only in respect to the fire-clay. The coal is worked altogether on the bord and pillar system, and in a similar manner to that described in operation in the Low Main. Three horses and 50 ponies are employed altogether in this mine. The air in circulation in the two seams of the Frances pit is about 30,000 cubic feet per minute. The ventilator, as before stated, is a Guibal fan, 23 ft. in diameter, 8 ft. 2 in. in breadth, erected at the Howard air pit. The ordinary speed is 55 revolutions per minute. This speed can be increased to 80 revolutions, if required, when 2-in. water-pressure is obtained. The fan has been at work three years, and has given very satisfactory results, the stoppages for repairs not amounting to 48 hours during that time. The driving-engine has one 20-in. vertical cylinder, 20-in. stroke, direct acting; two eccentrics, two slide-valves, by one of which the steam expansion is regulated. The steam is now cut off at one-fourth of the stroke.

The screens, elevator, and heapstead at the Frances pit are constructed of wood. Gasworks are erected in proximity to it, from which a supply is taken down the pit to light the roads at the bottom.

HOWARD PIT.—This has been 35 years in operation. There are two pits sunk to the Low Main seam, 7 yards apart, 30 fathoms in depth. The downcast, which is also the coal pit, is oval in section; the other pit is 6 ft. in diameter, and is the air-pit in connection with the ventilating fan for the Frances pit. Coal is raised at the Howard pit by a 16-in. beam engine, 4-ft. stroke, direct-acting, 10-ft. cylindrical drum, with single-tub cages; each tub carries 8½ cwt. The output of coal is about 250 tons of coal per day. Two plain boilers—one 35 by 6 ft., and one 34 by 5½ ft.—supply the winding engine, the underground engine, the fan engine, and the saw-mill engine; these boilers are fed by a horizontal "Universal" steam-pump of 4-in. cylinder and 2-in. ram. There are two hauling engines placed in the Low Main seam; one near the bottom of the pit has one 11½-in. horizontal cylinder, 20-in. stroke, wheels in ratio of 1 to 3; two drums, 2½ ft. in diameter, on two separate shafts, are moved by slide carriages. The engine is supplied with steam from the surface boilers; it pulls in and out on a plane going south from the pit for 700 yards in length and nearly level by means of tail and main ropes. About 1100 yards from the pit in the same direction another hauling engine is placed on a hill, having a bank on each side of it; this is a 15-in. beam engine, 3-ft. stroke, wheels in ratio of 1 to 2. One drum is 6 ft. in diameter, and is for the bank (400 yards in length) adjoining the 700 yards plane last named, and dipping slightly outwards. The other drum is 4 ft. 3 in. in diameter, and is for hauling on the bank on the inbye side of the engine, dipping 4 in. per yard, 240 yards in length. The tubs in each case run down by gravity. This engine is supplied from a plain boiler placed near it, 25 by 4½ ft. An upcast pit near this engine and boiler is the ventilator for the Howard Mine; the rarefaction is caused solely by the boiler fire and the escape steam of the engine.

There are large and convenient workshops adjacent to this pit for making and repairing colliery work, and a 11½-in. horizontal engine

and circular saws. Three locomotives, belonging to the Netherton Coal Company, are used for the conveyance of their coal along the private branch of two miles, and along the North-Eastern Railway to Backworth, for shipment in the Tyne and Wear Docks.

THE RATING OF COAL MINES.

SIR,—I have read many letters published in the Journal on this vexed and important subject; I have also taken upon myself no small amount of trouble in seeking information in our Black Country, with a view of ascertaining whether what has been said of irregularities, &c., in the rating of coal mines, has been based on truth or fiction. The result of my enquiries, I am sorry to say, fully confirms the numerous statements made as to a want of system and regular mode of rating coal mines in Staffordshire. This question of rating coal mines has been more warmly debated in the Stourbridge Union than elsewhere, and, as stated by my informant, because the want of system had reduced the rateable value on coal mines (the most valuable in the world) to a mere nominal sum; and in order to lay this particular case before your numerous readers, as a case in point, I give you a statement as under, which will at once demonstrate in figures the clear facts, as published in one of the local papers on Feb. 19. You see it is confined to a few of the colliery owners in Kingswinford parish, who appealed against having their rates raised from a nominal sum to what had been agreed to at Worcester:—

Name of Appellant.	Rateable value for rate granted Jan. 4, 1869.	Rate made Sept. 6, 1869.
Messrs. Brown and Freer.....	£ 92 18 0	£ 350 0 0
Sir Stephen Glynn.....	162 0 0	696 0 0
Messrs. John Hall and Co.....	0 0 0	373 0 0
Messrs. Walker and Edwards.....	0 12 0	200 0 0
Messrs. Chavasse and Co.....	0 0 0	357 0 0
Mr. Edward Bowen.....	41 18 0	115 0 0
Messrs. J. and W. Pearson, Rectory..	119 15 0	289 0 0
Messrs. J. and W. Pearson, Stallings..	21 16 0	189 0 0
Mr. John Raybould.....	70 0 0	298 0 0
Messrs. R. Mills and Co.....	197 0 0	650 0 0
Executors of the late Mr. A. B. Cochrane	168 11 0	937 0 0
The Corby's Hall Company.....	113 3 6	1,000 0 0
Messrs. J. Bradley and Co.....	555 0 0	3,368 0 0
The Earl of Dudley.....	1921 0 0	9,573 0 0
Total.....	£4012 13 6	£18,395 0 0

* These sums represent the rate as agreed between the Assessment Committee and coalmasters, rather than go on with the law, when before justices on appeal Feb. 19, 1870. The aggregate sum was more than double when it stood as the overseers put it—at one sixth.

Sad as this state of things may be, it is said there is more room to complain. My object was to get, if possible, at the root of discontent; I therefore resolved to find out the rent or royalty on which mines in this important district are taken or rented at; consequently I called upon a gentleman in one of the leading offices, who informed me that best thick coal pits had been let at a royalty of from 2-5ths of the selling price at the pits; and that, taking the high rate at which coal is now selling, and the low rate of wages, about 1-4th of the selling price would be the average value of thick coal mines; some would be let at more and some at less. Brooch coal and heathen coal, and ribs and pillars of thick coal, called broken mine, would let at 1-6th of the selling price, some being worth more and some less. Having so far satisfied myself as to the rent paid on coal mines, I wished to be informed—Q. What the tenants paid for damaged land?—A. Our office takes 5s. per acre per annum, and calls upon the tenant to convert the spoil-bank into farm land, by levelling and re-soiling it, at the termination of the lease, or sooner in case all his mines under lease should have been gotten.—Q. How were the mines rated in Kingswinford parish, when, as represented in the foregoing account, of the value of 4012 13s. 6d. per annum?—A. I cannot inform you how they were rated at that time, but they are now rated as under—Best maiden thick coal, 1-8th at the trucks, boats, or carts at the pits; brooch coal, heathen coal, and ribs and pillars of thick coal, called broken mine, on 1-12th of the sales at the pits, carts, boats, or trucks, from which 15 per cent. is deducted in favour of the coalmaster, to keep the whole in repair, &c.

Q. If damaged land, for which so high a rent was taken, paid poor rates?—A. No.—Q. If the mines so rated were valued by a competent man?—A. No. When my attention was called to the rents or royalties given above, I enquired—Q. Who fixed the rates?—A. Oh! I think it was the Assessment Committee, who entered into a compromise with the coalmasters rather than go on with law.—Q. If I understand you rightly, the overseers had rated the coal mines on a scale higher than is now paid?—A. Yes; as much again, and the coalmasters appealed against it; but rather than go on with the law the Assessment Committee compromised the case, by taking 1-12th in place of 1-6th, and then deducted 15 per cent. Just so said my friend.—Q. Why did they rate the mines for 1-6th part without a valuation?—A. Because a bargain had been entered into by all the guardians and parish officers at a meeting held at Worcester some years ago, over which Sir John Packington presided, to rate all the mines in the Union on 1-6th of the sales.—Q. Had they ever been so rated?—A. Not in Kingswinford parish, but in Cradley parish and in other parishes of the Union they had been so rated.—Q. Are these other parishes now rated on 1-6th?—A. No; as soon as the Assessment Committee reduced the assessment on coal mines in Kingswinford parish, rather than go on with the law, they reduced the assessment on all the other places to the same level, without being asked?—Q. Was all this done by the Assessment Committee without a valuation being made by a competent person?—A. Yes; and it will so continue.—Q. But if it is wrong, why should it so continue?—A. Because the Assessment Committee consists of hotel-keepers, shopkeepers, &c.—men who do not understand the value of such property; and, again, the coalmasters have great power in returning the guardians, and it is from the guardians the Assessment Committee is selected; and the few guardians who would have all rates made according to law have little or no power beyond making long speeches, for which they get paid with abuse as they go forward.

I have now given the outline of an account rendered by one whose position enables him to know the whole of what is called a vexed question; and by referring to the above table we see the rateable value of coal mines raised from 4012 13s. 6d. to 18,395 0s., and now it is pretty well understood they are rated at 50 per cent. less than their rental value, and 15 per cent. taken off that. For damaged land the tenant pays 5s. per acre, but pays no poor rate on that rent. At the end of his lease he has to level and re-soil, or pay a lump sum down, which he 99 times out of 100 pays, because the chances are that he has no soil to put upon it. The effect is that so much land has paid two or three times more rent than common, during which time it has not paid 1d. poor rate, and at the end of the lease it is so much land wiped out the poor rate book. The above is the true state of things, as represented to me.

In going into this case we have to ask ourselves a few questions:—1. Do the coalmasters know the law? Do they know that a coal mine should be rated on what it is worth to rent from year to year, regardless of what it may have cost to sink pits and erect engines, &c., subject to such a percentage being allowed as will be a reasonable sum to keep the same in good repair, which may vary from 5 to 15 per cent., as the case may be?—2. In case the coalmaster knows the same, and objects to be rated according to law, and by hook or by crook escapes, and thereby throws an unjust weight of rates upon the classes about him, who are less able to pay than himself, he does a double wrong, and in my opinion he is as bad as the man who robs the poor man of his hard earnings when on his way home to his starving wife and children; and, although he is not so guilty in the eye of the law, he is not the less as bad as the latter is.—3. In case the coalmaster, who is striving to escape his poor rate, does not know the law, then means ought to be taken to make him know it.—4. I hope the Hon. Mr. Goschen, and his friends at the Poor Law Board, will take such steps in reference to the rating of mines as will compel those who rent to show their lease, agreement, and rent account, when called upon.—5. All poor rate appeal cases before the Assessment Committee should be open to the public and reporters—that which is good for each must be good for all.

The able letter of your correspondent, "M.E. and C.E." (in the Supplement to the Mining Journal of Nov. 12) cannot fail to invite the attention of all who feel an interest in truth and justice. The cry has gone forth, and those who are at the head of the Poor Law Board are looked to make such alterations as the importance of the

rotten system of partial rating in our Black Country requires. In Kingswinford parish it appears that after a great improvement the land rented at 5s. per acre pays no rate, and the mines comparatively worth 20s. are rated on 10s.

A Case in Point.—For instance, if a man sells 12,000s. worth of coal in a year he is rated on 1-12th, which on 1000s., at 3s. in 1s., will be 150s. But should he be rated on his rent, which is on 1-6th, or 2000s., his rate will be 300s., just double. We are told that "whatever is right," but I cannot believe in such a doctrine. Our friends in the Black Country have much to complain of, and I pray that those who are pressing for justice will succeed.

Birmingham, Dec. 12.

MECHANICAL VENTILATION OF COLLIERIES.

SIR,—In reply to your correspondent "R. F." in last week's Journal, there are to my own knowledge fifteen ventilating machines erected in the counties of Durham and Northumberland, and eleven of these are Guibal fans. They work most satisfactorily; they have been put down as yet principally at pits of moderate depths, in which cases they have a great advantage over furnaces in respect to economy of fuel. There is usually no attendant required for a fan engine near the colliery, and the saving of fuel is in accordance with depth of pit; the furnace gains in power as the depth increases. The board and pillar system of working has been the established practice of mining in the Northern Counties for ages, and is still the system followed in most collieries. The largest machine yet erected is that at Usworth Colliery, described in the Supplement to the Mining Journal of Nov. 26, 1870.

Dec. 13.

COAL-CUTTING MACHINERY.

SIR,—Referring to Mr. Hurd and the anonymous correspondents on this subject in the Supplement to last week's Journal, I beg to say that the statements I have given respecting the abilities of his machine were taken from the Mining Journal, and, therefore, are not my assumptions. He does not attempt to disprove my assertions, but accounts for the retrograde movements by cutting wider grooves—practice, I suppose, having suggested to him that it is better to cut away 6 in. of coal than 2 in. My intentions are obvious; neither do I wish to conceal them, by allowing "a brother inventor" to lay claim to that which I consider belongs to myself; on those grounds I considered it my duty to call Mr. Hurd's attention to my patent, which I did in the letter he has published. I saw his machine at his works, in business hours. I simply walked into the place alone, asked for Mr. Hurd, and was informed he was not in. I then asked if I could see the coal-cutting machine, and was answered—Yes, with pleasure. I had no written order, and was not asked for one, or any other question, therefore Mr. Hurd's statement respecting the "written order to view" could not be correct—at least in that case. Referring to "Wharfedale Silkstone," I say that my sympathy is with the inventor, but not with others. To "Vindex" I will simply say that I date from the successful introduction of the pick-machine, and not from the patenting of "Menzie's" fire-engine, in 1761, No. 762. The evidence of its introduction I imagine he would lack to produce. And in his claim he says—"By means of a chain a wheel is turned round," &c., and not as "Vindex" states—"By means of a wheel a chain is turned round," &c.

"A Constant Reader," I consider, does not know what he is writing about, I therefore, excuse him. With these brief remarks I shall close my correspondence with those who write in the dark.

Dec. 13.

J. ROTHERY.

ON BOILER EXPLOSIONS, AND COLLIERY ACCIDENTS.

SIR,—It may, perhaps, be fairly assumed that, on the whole, colliery accidents are likely to be to a great extent obviated. It must be conceded that the necessary knowledge and skill for the prevention of underground accidents is being rapidly acquired by the classes of men who superintend, and also by those who attend to the details of their operations. The mass of knowledge now disseminated by the press, and especially that part of the press devoted to mining and engineering subjects, has to a great extent tended to this result. No doubt a great work is yet before us, and that is the imparting of sound technical knowledge to all subordinate officers in mines, but this also is in progress, and will in time be accomplished. The introduction of the Guibal fan is a most important step towards the safe ventilation of mines, as it gives the power to provide a powerful ventilation, and if the large volume of air provided is well manipulated the mines must be rendered much more secure. Falls of coal and stone cause many deaths, and a great proportion of those can, without doubt, be prevented by care and skill. Ropes and chains are pretty well understood, and when they have done their work they are discarded, sent to the old iron heap, and new ones properly tested are put to work.

But what is to be said about Steam-Boilers? An ordinary steam-boiler is employed (say) 30 ft. in length and 5 ft. in diameter, egg-ended, and this boiler is pressed up to 40 lbs. per square inch, a sufficient pressure for such a boiler. Now this boiler, if well constructed, and made with good iron 3/16ths of an inch in thickness, is presumed to be perfectly safe to work for a certain time, but the question appears to be what is the time such a boiler can be safely worked—is it 10, 20, or 30 years? It is clear, we think, from the direct experience that a boiler 30 years of age is about as safe to work as a horse (say) at 25; the latter machine is very likely to go down, and the former to fly up, or at any rate break in pieces. Is it, then, to be assumed that so long as a boiler will keep to its berth that it is safe to work? It is obvious that the resistance the boiler is capable of bearing may be very little indeed above the working load. We would suggest, therefore, that all boilers, and especially old boilers, should be subjected to periodical tests. We are aware that tests are objected to by many engineers on the ground that they have a tendency to strain and injure a boiler, and thus prepare it for explosion; but this is done simply by carrying the test too far, as there is no necessity to test a boiler beyond a certain point. A boiler intended to work at a pressure of 40 lbs. per square inch need not be tested up to 100 or 120 lbs., as is often done; test it up to (say) 60 or 70 lbs., and if this is borne without injury it may be assumed that the boiler is safe under ordinary circumstances. We would submit that the periodical testing of boilers is a subject well worth the attention of engineers, and it is also, perhaps, a proper subject for legislation. However, whether boilers are tested or not, it appears to be a bad and dangerous policy to work them up to extreme old age.

Newcastle, Dec. 14.

MINING IN CORNWALL—TIN AND COPPER.

SIR,—The article of tin must in future maintain a high figure in the market: supply and demand, we are told, govern prices of every commodity. Metals, like provisions, must be had. The oldest and greatest copper mines of a century standing in Cornwall, formerly enormously productive in copper ore, ceased when down to a depth of from 200 to 300 fathoms under the adit, or day level, to be any longer copper mines, but at such enormous depths the lodes have changed from yielding copper to that of tin ore. Dolcoath, now one of the richest tin mines in Cornwall, yielded to the depth of about 240 fathoms from the surface over 3,000,000s. sterling in copper ore. Cook's Kitchen, Tincroft, East Pool, Carn Brea, and the Phoenix mines, now rich for tin, were formerly rich copper mines, and others I could name are likely at greater depth to become tin-producing also.

The demand for the article of tin is greatly on the increase. The islands of Banca and Billiton do not appear to contain lodes or veins of any importance; and, as is known, surface deposits have their limit. The great copper mines in every country appear to be fast exhausting, so far as the profitable working of them is concerned. The depression of some 30 or 40 per cent. in the price of copper during the last few years caused several of the most extensive and productive copper mines in Cuba, Australia, Chili, America, and Canada to suspend all operations, many of them never again to be opened, probably. The consumption of copper, like that of tin and lead, is on the increase. The high standard for copper during the ten or twelve years previous to the panic of 1866 caused such immense returns of copper to be made that most of the greatest mines are exhausted.

The future prosperity of British mining will much depend upon the liberality of the lords of the soil, as regards the royalty or due,

Encouragement must be given to capitalists to invest their capital on a larger scale at home, and keep the strength and power of the nation supreme.

The present state of the great copper mining districts of Cornwall must be apparent to all who visit that county; and but for the great perseverance of a few gentlemen in risking their capital in making deeper explorations the state of things in Cornwall would at present be deplorable indeed. Enterprise has saved that county—Cornwall, as many persons who, a few years ago, thought it was exhausted of its treasure, now feel that brighter days are yet in store. Talent is good, but industry is the great secret of success. Labour is the pioneer of wealth. Employment promotes emulation, and keeps the people from beggary, and a multitude of evils which invariably follow; and liberty promotes enterprise. We are told there is as good fish in the sea as ever came out of it.

Dec. 13.

A. BENNETT.

BORING MACHINERY.

SIR,—I observe, in the Supplement to last week's Journal, some remarks made by Prof. Ansted on the Boring Machines working at Mont Cenis Tunnel. He says—"The stone experimented upon being of the hardest kind the effect is not seen for several strokes; but, within two minutes, during which the writer watched the experiment, a steel chisel was completely blunted and rendered useless, but there was a hole made about 2 in. deep in the mass of quartzite operated upon." Now what, I should like to ask, would the Professor say of a machine, weighing little over 3 cwt., cutting a 2-in. diameter hole through a 3-ft. cube of the hardest Aberdeen granite in 3 1/2 minutes? But this I, with several others, saw repeated three times with the same drill-point without sharpening, and without its becoming at the end of the third hole either blunted or rendered useless. This wonderful performance was accomplished by a machine known as the "Barleigh Rock Drill," at the stone wharf of Messrs. Freeman, at the Commercial Docks, Deptford.

Duke-street, Adelphi, Dec. 12.

THOS. A. WARRINGTON.

TERRAS TIN (ST. STEPHEN'S, CORNWALL).

SIR,—I beg to ask the manager of the Terras Mines to state in next week's Journal the quantity of black tin he has sold since his 48-head stamping-engine went to work last April. I cannot discover by the Journal that more than 10 tons have been sold in seven months. He tells us that he has an elvan course from 30 ft. to 50 ft. wide, inexhaustible for tin ore, which will produce 2 cwt. of black tin to 10 tons of tin-stuff, independent of other rich lodes; that he is erecting and can stamp with 200 heads 200 tons of tinstuff daily—consequently, his 48-head stamps should have been stamping (for it is said to be working beautifully) 48 tons daily. This, at 2 cwt. per 10 tons, would give about 10 cwt. of black tin daily, and in an ordinary month of thirty days (for stamping-mills are never idle on Sundays if there is work for them) should produce 15 tons, and in the past seven months 100 tons of black tin. If he has sold only 10 tons I shall be glad to hear how he can reconcile his report with the fact; and, in giving us the actual sales from the Terras Mines, perhaps he will also state the amount of the monthly cost. The late Stannary Law Act says that mine meetings shall be held not less than once every four months. What is the penalty for non-observance of this law? Can you, Mr. Editor, tell us?

If the Terras Mines can raise from an inexhaustible source 200 tons of tinstuff daily, which will produce 2 tons of tin, or 60 tons monthly, at (say) 70s. per ton, equal to 4200s., and give 50 per cent. profit, this will give 25,000s. per year, or 10 per share profit, and pay off their capital in one year, and, by multiplying their stamping-power double or treble this sum yearly.

I remember, Mr. Editor, in the days of the late Mr. Joseph Lytle, hearing a calculation made of the wealth of the Relistian Mine in this way—The lode is worth so much per fathom for copper and tin; there are so many thousands of fathoms in an acre; and the Relistian Mine set contains so many acres. The gross estimate thus obtained was enormous—some millions sterling; but, unfortunately for the shareholders, many of whom purchased shares at large premiums, the mine, after a brief career, was abandoned.

I do not wish to infer that the same fate may befall the Terras Mine—indeed, I am anxious for information, that the reverse may be safely anticipated; for I am—

AN OLD MINER.

HONOUR TO WHOM HONOUR IS DUE.

SIR,—I did hope that the letter inserted in the Journal of Dec. 3 would have induced Capt. Pryor to come forward at once, and do justice to an individual referred to therein. Instead of this, a letter in last Saturday's Journal says the only merit my letter possesses is "perfection in its incoherence." This I leave to the judgment of impartial readers. My object was plain, and it is no answer to say because the Duchy official did not prohibit the sale of the copper mounds until 1870, or discover sufficient tin in the Prince of Wales Mine to pay, that the whole merit of the discovery is due to Capt. Pryor. It is a well-known fact in this district that the present manager of New Great Consols sold thousands of tons of copper mounds, being at the time, I presume, entirely ignorant of their value for tin; and also that such sales were lamentably distressing, not only to the shareholders, but the working miners, whose wages, I am informed, were not paid. I do not desire to say a word in disparagement of Capt. Pryor, further than to show that he himself made what must now be admitted a great mistake in this dealing with the ore of New Great Consols. I have nothing to do with the Prince of Wales Mine, but I say the managers there are quite competent to take care of themselves, and believe it will come out in the enquiry about to take place, not only that tin is known to exist in the mine, but an accumulation of tinstuff has been made for some years past. The important question is—Will it pay? This problem has yet to be solved in New Great Consols, and as the present returns of tin from this mine are being made from ore broken in former workings, under circumstances previously alluded to, the value of this mine can only be properly ascertained when the accumulated pile is exhausted. For the sake of the district, I do hope that New Great Consols will prove the prize of 1871; but it will be much more satisfactory and creditable to see a readiness to do justice than to withhold merit to whom merit is due.

Stoke Clumland, Dec. 11.

OSWERYN.

OLD REDMOOR MINE, AND ITS MANAGEMENT.

SIR,—There are a number of complaints of the indifference exhibited by mine officials in attending to their respective duties; and if there is one mine whose "committee of management" are more deserving of censure than another, I think it is Old Redmoor. Taking the past and present as a criterion, it appears as if they were intended to raise all the tin that they can from their present workings, and then abandon the concern, as they are employing all the men they can stop round away, and only driving the 25 west, yet I find by the November quarterly report that they are employing 72 men. Why not take means to extract the tin to be seen in the large quantities of mounds underground and at surface? If New Great Consols or Prince of Wales can work it at a profit, most certainly Redmoor can, having no water charges to contend with. From what can be seen in the 12 and 25 fathom levels there is no doubt large profits can be made, and why operations have not been brought to bear upon it before now is past my comprehension. It is highly probable that it will be more than two and a half to three years before the old mine is drained to enable operations to be resumed on the lead lode; therefore, I trust the executive will see the necessity of removing the engine and stamps (if necessary) at once to operate upon the tin and mounds, and sink deeper for another level. There is material enough in sight to last for years. If this course is actively adopted I confidently affirm our shares will soon command a good premium, and calls will be replaced with dividends. In conclusion, let me beg my fellow-shareholders to look after their property more, and not suffer this matter to rest until an improvement is carried out.

A SHAREHOLDER.

THE TIN AT NEW GREAT CONSOLS.

SIR,—The observations of "Lax," that sales of ore did not necessarily prove the fact of a mine being a profitable one, is too well known to admit of discussion. That the discovery of tin at New Great Consols is a most remarkable occurrence no one will attempt to deny, but the very fact of its being found under conditions hitherto unknown is a sufficient reason why caution should be exercised before relying upon profitable returns. For my own part, I do not believe the mine will pay profits, and there are several practical agents in this neighbourhood who are of this opinion. The ore has not only to go through a greater number of processes than is usual in tin dressing, but it has to be cleaned for hours before it is finally dressed and made marketable; and all this adds very much to the expense of working. The stuff is also very hard, and by no means rich for tin, and as the whole of the lode has to be broken and dressed, it follows that the inability of the dressers to sort the richer from the worthless stuff adds greatly to the cost per ton of stuff treated. My opinion is that the tin is better in the capels of the lode, but that this does not occur in any quantity. I should like to know what the monthly loss at the mine is; it is rumoured that they are losing over 500s. per month already, and that more capital is going to be raised in order to work the tin on a larger scale. I should advise the tin being worked on a small scale at first, in order to test it sufficiently.

Callington, Dec. 13.

A LOCAL AGENT.

WHEEL AGAR.

SIR,—For several weeks past I have read with great interest the reports of this mine, and am at a loss to know what is become of the once so-called important point—the cutting of the East Pool lode in the 170 cross-cut. Does not this lode run through the sett? If not, why drive the cross-cut, or sink the flat-roof shaft? Have these two points been dialled jointly with the lode in East Pool by Mr. Henderson, of Truro? If not, it should be done at once. Look at the advantage Tincroft derived by Cook's Kitchen levels being brought up to the boundary, and some little excavations made beyond that boundary. The important discovery of tin made in the 160 ft. level, which almost induced the adventurers to erect a steam-stamp on the mine, instead of selling the tin in the stone to bargain buyers. The sinking of the engine-shaft just on the junction of the elvan and greenstone courses, as well as the driving of the different levels west of this shaft, in and upon the same elvan course as they have in the adjoining mine, North Wheel Croft, at and about which rich courses of tin have been met with. Are these not important points, and have they been accomplished? If not, I should think it is time for the adventurers to call in some independent agent to inspect the mine, and report fully on the tin points. The agent should be one that does not job in shares, and not largely interested in tin streams.—Cambridge, Dec. 12.

A SHAREHOLDER.

[For remembrance of Original Correspondence see to-day's Journal.]

DOWN AMONGST THE GREENSTONE.

THE IRON KINGS, THEIR DUSKY REALMS, &c.

BY J. RANDALL, F.G.S.

In proceeding from the extreme northern end toward the centre of the South Staffordshire coal field the country is found to wear quite a different aspect. Instead of bright red rocks, with fresh white pebbles, rural nooks, and real country scenery, grey sticky marls and dirty coal-mud are met with, together with old pit mounds, which resolutely resist every effort at vegetation to give them a more seemly appearance, and which archeologists may almost mistake for old British barrows. Here and there isolated chimney stacks hang their heads, as though conscious of their uselessness, whilst fragments of massive masonry and rusty and disjointed limbs of machinery tell of former activity and enterprise, but on a smaller scale than now distinguishes similar works of the kind. Pits long ago abandoned are being re-opened, or sunk deeper in search of coals which the "old men" have left. In places the minerals have been thrust up by faults, so that they can be obtained by means of "open works;" and everywhere the "underground" has been so perforated that creeps and subsidences have left their impressions on the buildings; whilst the surface is cracked and warped as if by an earthquake. Now and then may be heard the hissing of steam, the rattling of chains, the discordant screech of wheels and pulleys, with a chorus of similar sounds.

The mines now run no longer even, as at Cannock, but are broken up and intersected by faults, some of which traverse the beds for short distances, and alter their levels for a limited space, then disappear. Others make very material changes, like the "Great Bentley Fault," which causes a difference of level of 120 yards; and in addition to faults of fracture and dislocation, which split, cross, and tilt the measures, forming troughs or arches, the result of upheavings and subsidences, there are innumerable crumplings and contortions, caused by masses of green rock, or basalt, which have been intrusively thrust in a liquid state in and amongst both coals and ironstone. Our object was to witness the pranks played by this greenstone on some property which belongs to the Duke of Cleveland at Pool Hayes.

It was a nasty wet November day, cold enough to make one shiver; and rain and sleet came down together as we trudged along deep rutted roads from Bloxwich past the "New Invention" to the Pool Hayes Farm. A warm welcome, a good fire, and hospitable treatment by friend Fenn and his family, however, restored our spirits; and encased in flannel—rather deficient in point of capacity, however—we prepared to descend one of the fourteen shafts with which Mr. Fenn and his brother-in-law have pierced the Duke's property. It was "St. Monday"—"a day in which thou shalt not labour," as the command, self-made, runs among the colliers; but the steam had been kept up, and down we went. It would, of course, be simply ridiculous to describe to the readers of the Journal the descent of a shaft, and we shall merely remark that we descended No. 7 pit, in which the Sulphur and Yard coals stand exposed in the shaft. The next, the Five-foot coal, comes in just about the sump, and is separated from the Yard coal by measures of clunch and rock, 14 yards in thickness. Although widely separated, they are said to represent the New Mine coal, which forms a single seam in the Wolverhampton district, from 6 to 7 ft. in thickness; thus affording another illustration of a change in name, and of the fact referred to in our last of coals branching off in a northerly direction from a few inches to many yards apart.

It is into this Five-foot coal that the greenstone has thrust itself, completely changing its nature, charring it, coking it, and wrenching it in all directions. Passing from the bottom of the shaft, we ascend an incline plane, following the coal as it rises, with a "jump up" now and then, sometimes of a few inches only, then of several feet. Having ascended this eminence, we passed over 15 yards of table-land, then descended to rise again, and so on; only that each hill, each valley, and each bit of table-land differs from the preceding, and there is no uniformity or regularity about it. Sometimes there is a white thread of this lava-like rock only thrust in amongst the coal, then it assumes the form of an arch, or masses itself in long solid walls, and at unexpected turns meets you in the most inconceivable shapes.

How Mr. Fenn had the courage and perseverance to dodge about it, to grope his way round it, and where he could not get round to bore his way through it, in order to get at the coal which it held fast in its grip, we cannot tell. The coal itself is charred, burnt, and hardened into rock, so that whole acres have to be abandoned as worthless, and a bit of good coal is the exception rather than the rule. Over the coal is a whitish rock, described in some other parts of the field as rock binds, from 20 to 30 ft. thick; and it is interesting to observe how completely this conforms to every little irregularity in the coal. If, for instance, there is a slight sharp recess, the rock follows it, conveying the impression that it must have been in a fused or plastic state: in fact, in these works it has the appearance of baked fire-clay. Both the heat and the pressure must, indeed, have been intense at the time of the injection of this volcanic trap, which, although flowing in sheets for the most part, has run under the superincumbent rocks, carrying fragments with it, partly fusing them, and squeezing them in a semi-molten state into the vertical fissures it has made. One would naturally expect to find that the trap had come directly up from beneath: on the contrary, it is found extending for miles, maintaining pretty much its level between the measures it has specially attacked with such intensity. Now and then it rises, it is true, and forces its way through superincumbent rocks, and may be seen even cropping out on the surface. Below the Fire-clay coal in Mr. Fenn's shaft the green rock assumes a thickness of 40 yards. Yet we are told the lower measures, consisting of the Bottom coal, the Gubbin ironstone, and Blue Flats, are comparatively unaffected by it, particularly the latter, which are worked without inconvenience. In some places the Bottom coal has been entirely cut out by the green rock, which in others is found resting directly upon that coal.

It is curious to wander in and out amongst the ramifications of this old-world lava, and through the labyrinth of roads Mr. Fenn has driven in order to get the Five-foot coal; and we shall certainly retain a lively recollection of our wanderings through these subterranean caverns for some time to come. It would have been an advantage, perhaps, to have been somewhat less in stature; but here we were, in a warm steamy atmosphere, with the perspiration trickling down, stooping, yet knocking our heads against the roof, for it was impossible to look up, and equally impossible to avoid some sharp projecting ridge of greenstone, that seemed now and then to lay in wait to bar our progress. Sometimes we had to go on all fours, and once or twice to wriggle on like worms through narrow openings, the entrances to which were stopped merely by whips of straw. Mr. Fenn seemed bent upon taking us through the whole of the underground burrowings in connection with his fourteen shafts, the bottoms of several of which we passed; but we had had enough, and, much to his amazement, declared against going further, with the request that he would next time send for the noble owner, the Duke of Cleveland, to inspect his own mines! We question whether any other man than Mr. Fenn could be found to have worked such a mine with the same means, and at the same time to make the works pay, seeing that after all the expense and difficulty incurred in getting the coal it has to be sold as an inferior article, and at an inferior price. Driven to the use of economy, he has invented iron "trees" for propping the roof. These are simply iron pillars, with caps, which he places on pieces of wood. They do not split or break, like timber, and can be taken down and used *ad libitum*. Mr. Fenn evidently is a model man in many respects: a man of principle and of piety, a man of severe discipline we could see, and a man of untiring energy. He has worked in pits, or in connection with pits, since he was 10 years old, and evidently feels a pride and a pleasure in his profession.

On regaining the surface, Mr. Fenn took great pains to point out where we had and had not been; but the surface is a plain, a smooth bit of table-land, excepting that where the coal has been extracted it has collapsed unequally; also from the walls of greenstone retaining their position. Where the coal has been altered, so as to be completely worthless, and has, therefore, been left, it shows itself by a slight elevation on the surface. Mining under such circumstances

appears to be like a game of chess; the miner gets checkmated here and there, and has to yield at times; but he goes on again, hoping to win something which shall compensate him. Mr. Fenn is just now putting down his sixteenth shaft, at a point nearer to Essington, where he hopes to meet with something better. He has first plodded his way, however, underground pretty near to the spot where he is sinking, and hopes, like McCawber, that "something will turn up." At this point he commences work with the New Mine stone on the surface, and trusts he may meet with portions of coal less "blackened," and consequently retaining its inflammability.

To those familiar with the South Staffordshire field it would seem unnecessary to add that this is only one of the many instances in which not only this but other coals have been affected by the same kind of igneous rocks. For the information of others, labouring in more favoured districts, we will merely observe that a very large portion of the district has been similarly affected, the rock assuming a thickness equal to that at Pool Hayes. In some cases it is found in the lowest sandstones of the coal measures, and just above the Silurian shale.

Sometimes instances occur of this old-world slag—thrown off by the great furnace of the globe—rising to the present surface; and an interesting case of the kind may be seen at Pook Hill, which presents a most interesting and instructive example of the kind, where it is quarried and laid open to view. It has been opened to such a depth that the quarry looks like a great crater, or rock-bound cauldron, through which the mass of incandescent mineral matter has boiled up, and cooled down, assuming in the process that well-known columnar and jointed structure of which Fingal's Cave and the Giant's Causeway present such beautiful illustrations. Around it, concentrically arranged, and dipping from it in all directions, are pre-existing stratified rocks, which it brought up with it. Unlike sub-aerial craters, there are no traces that we observed of ashes; it appears to have been a dome rather, or cone, beyond which the upheaving force was probably insufficient to propel the trap. Unlike the greenstone, which is of a light-green colour, this assumes the appearance of basalt, and has a jointed structure; in fact, it presents a magnificent example of prismatic jointing. Huge columns stand clustered together, beautifully articulated, some perpendicular, others in a leaning position, and almost reposing upon the upright ribs that support them. The quarrymen have opened a crater-like space around the mass, which they have reduced to a centre. They take advantage of these natural divisions of the rock by joints and planes, and reduce the column to paving stones, whilst the refuse serves the purpose of road material.

PRECIOUS METALS AND PRECIOUS STONES—No. II.

In the Supplement to the Journal of Dec. 3 was published the first of two highly interesting lectures upon this subject by Prof. JOHN MORRIS, F.G.S., of University College, delivered at the London Institution, Finsbury-circus. In the second lecture, embracing Gems and Precious Stones, the lecturer remarked that it had been stated that one of the most frequent questions asked by the visitors entering the late Exhibition in Paris was—Where are the jewels? showing the interest felt in these bodies, and he would, therefore, attempt now to interest them with a general description of the physical characters and modes of occurrence of jewels and other ornamental stones.

Among the many natural substances which belong to the mineral kingdom some are known as precious stones or gems. These, however, are but few in number, and form but a very small portion of the mineral species at present determined, and which now amount to more than 700. The additions which are continually being made, and which during comparatively few years past have so much increased our mineral lists, have not added a single new form to the group of the so-called precious stones. Most of them have been known from the earliest period of antiquity, for we find them mentioned in the sacred records at a comparatively early date—the twelve stones on Aaron's breast-plate, engraved with the names of the twelve tribes of Israel. Not only were they in those early times highly prized as objects of ornament and decoration, but they were used as emblems and offerings to the deities—held sacred as charms—considered to possess many medicinal virtues; and in later times, in Germany, the twelve months of the year were typified by certain stones, upon each of which was engraved the zodiac sign of the month which it represented. No other department of natural history has probably received so many systems of classification as that of the mineral kingdom, and this has been partly dependent on the value assigned to certain characters by each successive authority; and thus the various phases through which mineral arrangements have passed have been dependent on the advancing knowledge of their physical and chemical characters, for to the latter science is mineralogy deeply indebted. Formerly mineral substances were arranged simply as saline, combustible, metallic, and earthy minerals, and the precious stones were classed with the latter. In other systems, that of Weiss, the gems form a group by themselves, excluding garnet and diamond. The earlier mineralogists, as Wallerius, Born, and Romé-de-l'Isle, classed them as crystal gems; and Haüy placed them under three different classes—the diamond under *inflammable*, the topaz under *acidiferous*, and the remainder under *earthy* substances. In others they are again separated and arranged according to their chemical composition and form, as in the classification adopted at the British Museum, based partly on the chemico-crystallographic system of Gustav Rosa.

Few, however, as the precious stones are, they have from their rarity and beauty, as well as the tendency to personal decoration, been the subject of extensive imitations, sometimes so carefully prepared as to be difficult to distinguish, while other less valuable substances have been also largely used for various ornamental purposes. We may, therefore, classify the different natural and artificial bodies used in personal decoration under the following heads:—

- 1.—Natural mineral substances—sapphire, beryl, garnet, zircon, topaz, chrysoberyl, amethyst, peridot, opal, agate, cat's-eye, turquoise, lapis lazuli.
- 2.—Natural organic bodies—diamond, amber, jet, odontolite, pearl.
- 3.—Natural and artificial substances—coloured agates, stones and glass (doublets), half-brilliant.
- 4.—Artificial substances—common coloured glass, strass or paste.

Imitative stones or gems of similar ingredients; these have been prepared by submitting definite proportions of the elements of the gems imitated to a high temperature in the presence of boracic acid, and thus sapphire, spinel, topaz, garnet, zircon, and other rare forms have been produced by Daubrée, Ebelmen, Deville, and others.

I wish, however, chiefly to direct attention to those minerals and other substances which are highly esteemed for ornamental purposes, and to some of which the term precious stones or gems is applied—the latter word being also used for engraved stones. They are called fine stones from the polish they can receive, and also hard stones from their power of scratching steel and other resisting bodies. As a group they are chiefly distinguished from other minerals by their transparency, lustre, hardness, colour, specific gravity, electricity, more or less refractive power, coldness to the tongue, and symmetrical crystallised forms, which are either that of the primary molecule or derived from it by the law of symmetry, and to which they can be reduced by cleavage with more or less ease. This facility of cleavage, or tendency to split along certain planes in the same mineral species, is frequently made use of by the lapidaries in cutting stones, and especially the diamond, and was used by them for this purpose long before the law which regulated it was discovered.

These minerals are found either disseminated in rocks, in veins, fissures, cavities or geodes in them, or in alluvial deposits derived from the disintegration of the former by meteoric and other agencies. Their crystalline and transparent state would indicate they have been slowly formed, so as to allow their integrant molecules to arrange themselves symmetrically, and this may have been effected by aqueous solution, hot vapours, or segregated out by molecular changes (metamorphism) from rocks which originally contained the materials of which they are composed.

The recent discovery of a new locality for the diamonds has to some extent increased the interest which has always been felt in that which is considered the highest and purest of gems, and the most beautiful among the productions of nature, although sometimes equalled if not rivalled by its allies, sapphire and ruby.

The diamond is the hardest substance known, hence the Greek name *adamas* was said to be applied to this stone; it is, however, very brittle, has a lustre, and in the rough state is devoid of brilliancy and semi-transparent, and somewhat resembling gum-arabic; it crystallises in the various forms of the cubical system, and occurs chiefly in octahedral, tetrahedral, and dodecahedral forms, parallel to the planes of the former of which; it cleaves with facility, a property rendered available in the cutting, as well as in the removal of flaws and imperfections in the stone.

To its great refractive and small dispersive power is attributed the brilliant lustre, and play of colour when judiciously cut, and thus it is the object of the lapidary so to arrange the faces when possible both above and below as to reflect back again, and in different directions, the rays of light, instead of allowing them to pass through the cut stone. The diamond is usually cut into one of three forms, partly, but not entirely, dependent on the original form, size, and perfection of the stone; these are termed the brilliant, rose, and table cut diamonds; the former is considered to be the most favourable shape for developing all its beauty. There is also the *lucques*, cut in India from flat and veinny stones.

The more nearly the rough form of the diamond is that of the octohedron; it is considered there will be less loss in cutting it, and the better it will be in many other respects. Its hardness is 10 in the scale of minerals, and the specific gravity is 3.5; besides being colourless, it occurs of various colours, green, blue, brown, yellow, pink, orange, and black.

Sometimes the diamond has been mistaken for the topaz, and also for sapphire when blue; but the topaz and rock crystal (known as Bristol, Irish, and Welsh diamonds) have been more frequently mistaken for it. It is readily distinguished from these two by the following characters:—

	Hardness.	Sp. grav.	Cleavage.	Form.
Diamond	10	3.5	Octohedral	Cubical
Topaz	8	3.5	Basal	Rhombohedral
Rock crystal	7	2.6	Difficult or conchoidal	Hexagonal

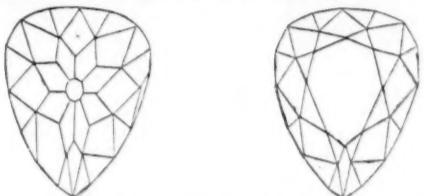
Hence the diamond differs in its crystalline form, brittleness, cleavage, hardness, and lustre from the other two, and still more from quartz, by its specific gravity; and from *paste*, which is sometimes made to imitate it, but which is much softer. It is insoluble and infusible, but is consumed at a high temperature, and is capable of being dissipated by directing with a lens the sun's rays upon it when suspended in a jar of oxygen gas, thus forming carbonic acid—an experiment originally made by the chemist Lavoisier. It is positively electric by friction, and has the power of emitting light when carried into a dark chamber, after having been exposed for some time to the light of the sun or the electric light. Its high refractive power led Newton to infer it was combustible, which was verified in the same year, 1693, by the Florentine Academy, and its composition has suggested that it may have originated from the slow decomposition or change of vegetable or organic matter, by which the other combined elements have been eliminated, and its near relation to plumbago and anthracite may have strengthened the supposition. It has also been suggested that it may have originated by condensation from a state of vapour, or from the gradual replacement of the carbon by some element, from its combination with chlorine or sulphur, or, as suggested by Prof. Maskelyne, "there is another direction in which the production of the diamond may be looked for. It is well known that iron, when surcharged with carbon, though it may dissolve it in a state of fusion, deposits the excess of carbon when it cools, but in the graphitic modification. Some other metal, or some change in the conditions with the same metal, might cause the extension of the carbon in the form of diamond." In illustration of this, I have here a fine specimen of crystalline graphite prepared by Mr. David Forbes from its solution in iron at a high temperature, and subsequent cooling. The varieties of crystalline form would infer a slow process and freedom of motion among the molecules, due to a viscous state. Like some other minerals, it occurs as male or twins, and sometimes one form enclosing another, showing subsequent aggregation, as in a specimen belonging to Mr. Martin; sometimes showing successive edges of the octohedral pyramid, and some forms have curvilinear edges and faces, a form rendered available in the glazier's diamond, the irregular octohedron, with rounded facets, being preferred, and which property was first investigated by Dr. Wollaston, who showed it to depend upon some crystallised forms of the diamond, in which the edges of the rounded faces were circular instead of straight, for it is the *rounded edge*, and not the extreme point or angle, of the diamond which cuts the glass, a similar power to which could be effected by giving the same curved form of edge to the ruby, rock crystal, and topaz, as also proved by Dr. Wollaston. Various other uses, besides for jewellery, are the diamond and its allies, carbonado and bort also applied, the latter two never being cut as gems. Diamonds are used for jewelling watches, 100 to 200 of them, or even more, so prepared weighing only 1 carat, and sometimes as small lenses for single microscopes.

Diamond splinters and powder are largely used for drilling, slitting, and polishing other substances, as in the preparation of sapphires and rubies for the jewelled holes of chronometers and watches, in the drilling of china and glass; and mounted diamond points are extensively used for engraving, as I am informed by Mr. J. W. Lowry (whose father first applied them for that purpose) that the ruling machine for tints would be almost useless without them, as the steel points wore so rapidly that it was impossible to get an even tint; they are generally used ground conically to a point, and also when split to make an angle or a natural point, and sometimes a great weight is placed upon them, so as to cut the copper deep enough at once, which is called dry pointing. With steel plates, etching is chiefly employed, but the tint is still mostly ruled by the machine with diamond, previous to the application of the acid, to bite in the lines as deep as required. (Specimens of diamond points, and of tinted plates engraved by means of them, lent by Mr. Lowry) were exhibited. Besides bort, which is sometimes applied to the fragments too small for jewellery, there is a substance called carbonado, found in Siberia and the Brazils, of a black colour, intermediate to the diamond and anthracite, but with the hardness of the former, and of a rough and irregular form, or may consist of aggregated crystals, destitute, however, of true cleavage. It is less valuable than the diamond, but from its peculiar character, being tougher and less brittle, it has been applied to various purposes, for the cutting of millstones, and also as a tool for tunnelling or quarrying, as in the lately invented diamond-boring machine, in which eight diamonds are employed, four on the outside, and four on the inside circumference of cylinder about 1½ inch diameter, and by which it is stated three-quarters of the expense of the usual manual methods is saved.

Diamonds are not extensively distributed; they have been chiefly obtained from Central and Eastern India, Borneo, Brazils, also from Sumatra, the Oural, at Mudjee in South Australia, California, and recently in South Africa, within an area of 500 to 1000 square miles, between 26° and 28° south latitude and 24° to 26° east longitude, chiefly confined, as far as at present known, to the Hart river, the Vaal, and some of its tributaries, and near the junction of that stream with the Orange, and along part of that river below its junction with the Vaal, and may thus have been derived from the disintegration of the rocks forming the Witteberg, Quathlamba, or Drakensberg, or from the elevated lands near the sources of the rivers draining into the present area. The diamonds are associated with pebbles of trap or basalt, containing zeolites, also quartz, calcedony, agate, tourmaline, peridot, garnet, &c. The proportion of large diamonds to small ones at present found is somewhat remarkable, as compared with other diamond fields, some weighing 40, 56, and 83 carats; the latter, after cutting, 46½, many generally being more or less coloured. Diamonds are usually found in alluvial deposits derived from the materials brought down from the hills bordering the higher parts of the valleys, as they are generally associated with a large assortment of rocks, minerals, and gems, as quartz, diorite, mica schist, gold, platinum, calcedony, kyanite, red hematite, magnetite iron, rutile, chrysolite, tourmaline, topaz, &c., sometimes with the black and opaque carbonado, and the crystalline concretions of translucent opaque, but neither useful for cutting. In Brazil the gravel or conglomerate is termed *cascalho*; when of broken quartz, *gurgulho*. Rarely has the diamond been found in the original matrix, but is stated to occur in hornblende slate, and in a flexible sandstone, named Itacolomite, from the Pic d'Itacolomi, in Brazil, consisting of siliceous particles, having freedom of motion within certain limits, and to which its

flexibility is attributed, although mica is sometimes present, but the geological age of which rock is not known. In Brazil, which affords the chief supply, they were first noticed in the early part of the 18th century, as stones found in the gold washings of the elevated districts at the Serro Frio, and about the sources of the Jaquetinhonha, San Francisco, &c., and were used as counters in card playing by the miners until their real value was inferred by a person who had seen similar stones in the East Indies.

The chief Brazilian mines (Mr. Martin informs me) are Minas Geraes, which is the most productive; the diamonds have a dull, frosted coat, and with a more or less greenish hue. Sincora, in the province of Bahia, discovered about 1843, was very productive for five or six years, the first two years yielding diamonds valued above half a million of money; they are generally of a yellow and brown tinge, but sound, with bright coating, and lose less in cutting, and are associated with the black and opaque carbonado. Bugagum, more recently discovered, yields generally distorted crystals of a milky white, pure white, and light brown colour, and resemble in some respects the Cape diamonds; the "Star of the South" was found here. Cuijaba yields very little, but in character like Sincora, and affords the best points for glaziers' diamonds. It is estimated since the opening of the Brazilian mines they have yielded 2 tons of diamonds. The quality and perfection of diamonds depend upon transparency, colour, freedom from specks, cavities, and flaws. Their value, up to a certain size, is estimated in carats, which is about 4 grains, or 3/4 grains troy, the value, however, depending on their purity, so that it might vary from 8/ to 12/ a carat, and is estimated, when more than one carat, by the square of the weight, multiplied by 10 or 12, according to its general brilliancy and form. Among the remarkable diamonds are the Mattan, 367 carats; Great Mogul, 279 9-10; Russian, 195; Austrian, 139; Regent, 136; Sanci, 106; Star of the South, 125; Nassac, 78; Koh-i-Noor, 102. The Star of the South, Africa, original weight 83, now weighing 46 1/2 carats, of which the following are the figures:—



[Models of the original size and present form of this diamond, as well as a fine series of precious stones, were lent for exhibition, by Messrs Hunt and Roskill; also an interesting collection of crystallised diamonds, and one in the conglomerate from Brazil, exhibited by Messrs. Bogg and Martin; and a collection of diamonds, brought by Prof. Tennant; and models of all the large diamonds, sent by Mr. James Gregory.]

[To be concluded in the Supplement to next week's Journal.]

GEOLOGICAL SOCIETY OF LONDON.

Dec. 7: JOSEPH PRESTWICH, F.R.S. (President), in the chair.

The Rev. J. W. Todd, D.D., Tudor House, Spidenham; the Hon. Henry Ayers, Adelaide, South Australia; R. W. Peregrine Birch, C.E., Palace Chambers, Westminster; Alfred Stair, 4, Surinam-terrace, Stratford, Essex; H. River, Carnac, of Simla, East Indies; Thos. Davies, 47, Rutland-road, South Hackney; the Rev. S. H. Cooke, Northbourne Rectory, Deal; J. S. Courtney, Penzance; John Johnson, C.E., Chilton Hall, Ferry Hill, Durham; the Rev. R. H. Morris, M.A., Principal of the Training College for South Wales and Monmouthshire, Caermarthen; and Joseph Drew, J.P., Belgrave-terrace, Weymouth, were elected Fellows of the Society.

The following communications were read:—

1. "On Fossils from Cradock and elsewhere in South Africa," by Dr. George Grey; communicated by Prof. T. Rupert Jones, F.G.S.

2. "On some Points in South African Geology."—Part II., by G. W. Stow; communicated by Prof. T. Rupert Jones, F.G.S.

3. "On the Geology of Natal, in South Africa," by C. L. Griesbach, Corr. Memb. of the K. K. Geologischen Reichsanstalt, and of the K. K. Geographischen Gesellschaft, Vienna; communicated by H. Woodward, F.G.S. The author commenced by describing the physical geography of Natal, and then indicated the character and distribution of the rocks which occur in that country. He stated that the granitic and gneissic rocks do not form the most prominent elevations, but they appear chiefly in the lower parts of river-valleys, and sometimes in small hills. Mica-schists and slates are found associated with the granites. The great plateau consists of an undisturbed sandstone, which the author identifies with the Table Mountain Sandstone, and lies horizontally upon the granites and old slates. The tops of many of the table mountains in Natal are crowned by beds of dark basaltic greenstone. The Karoo formation, which lies in part upon the Table Mountain sandstone, consists of a vast series of sandstone and shales, some of the latter containing beds of coal. The author agreed with Mr. Tate in regarding these beds as of Triassic age. At the base of the Karoo formation the author described a boulder bed, which he was inclined to identify with the rock described by Mr. Bain as "Claystone porphyry," and through this greenstone has forced its way. On and near the coast of the southern part of Natal some sandy marls and sandstones belonging to the Cretaceous series are said to occur; the author gave lists of fossils obtained from these deposits, which he identified with the Trilobitic series of India. Several of the fossils were described as new species. The author considered that the evidence adduced indicated that, after the development of the Table Mountain Sandstone, Africa and India formed parts of one continuous continent, afterwards covered by the Cretaceous sea. The area now covered by the Indian Ocean was the basin of a large series of lakes, and this condition persisted through a long period of tranquillity, lasting through the Triassic to the Upper Jurassic age. The greater part of this continent was then depressed and covered by the shallow Cretaceous sea. The economic mineral products of Natal were mentioned by the author, who referred to the occurrence of graphite, coal, gold, and copper.

Prof. T. RUPERT JONES commented on the importance of the paper, as throwing so complete a light on the geology of Natal, and proving the geological sequence to be similar thereto to that in other parts of Southern Africa. He remarked that the author had done special service by the great increase of information furnished by him regarding the Cretaceous rocks of Natal, and their equivalence to those of India. He also pointed out that Mr. Griesbach had proved that the Karoo formation was continuous to the other side of the great dividing range, and the flow of the Orange and Vaal Valleys, and that as Mr. Stow had indicated special action on the south side of the Orange Valley it was quite possible that the gravels containing the diamonds were of local origin, as Dr. Grey had suggested.

4. "On the Diamond Districts of the Cape of Good Hope." By G. GILLILLAN, Communicated by W. W. Smyth, F.R.S., F.G.S. Mr. Gillillan described his going through Colesburg to Hopetown, and thence across the Orange River to Backhouse; and then, after crossing the Vaal, up its right bank as far as Lekatlong. He noticed such diamonds as he saw or heard of, and described the locality as being thickly coated with sand, diamond-bearing gravel, and tufa, hard blue shales occurring here and there in protruding hills.

Prof. TENNANT stated that he had lately seen as many as 500 diamonds from the South African fields in the possession of one person, some weighing as much as 50 carats. He had seen another fragment of a stone, which must have originally been at least as large as the Koh-i-Noor.

MINING IN NORTH WALES.—At the Cardiff Naturalists' Society, Mr. Vivian read a paper on the working of the Mynyddu Mines. The working of these mines was undoubtedly of ancient date. The name "Mynyddu" is a compound word, and is made up of "myn," which means in the Welsh language, I believe, ore or mineral, and "dy," a mutation of "ty," which means house; so that we have the name Mineral house remaining, when it was only known as a farm place, and long after the knowledge of its connection with mines was lost. Besides the evidences of ancient mining which have been seen about it, it seems also that iron was smelted here a long time ago by the use of charcoal only. Considerable beds of slag and cinder have been seen about and even below the loam soil of the garden which surrounds the house. Smiles, in his "Industrial Biography," tells us that in Glamorganshire, as well as in parts of England, before iron was made by mineral coal as fuel, the people got to be alarmed at the rapid destruction of the woods in iron making, and about 200 years ago they succeeded in getting an Act of Parliament to prohibit the further manufacture of iron with charcoal, fearing that there would not be fuel enough left for domestic purposes. All this is rather amusing to us who live in this age and place of coal and iron, sending as we do our fuel by millions of tons to distant nations, and crying out in sorrow, if we do not anger, because they do not take more of us. It shows also how wonderfully the resources of nature—the bounties of Providence—are successfully developed to meet the wants of man. The ore found here is a brown hematite, of an average yield of metal, in bulk, of about 50 per cent., and exists geologically in the carboniferous or mountain limestone, just at the points where the limestone dips down northward below the southern edge of the great coal basin; the shales in which the coal bed mainly lies commencing here, and extending back to the hills, north and west. The ore is not stratified in a bed like coal, nor is it found in a regular vein like many metallic ores, but it lies in irregular masses in the limestone, as if the cavities in the limestone had been afterwards filled with the ore. I am informed by those who were more early acquainted with it that the mining recommenced here in May, 1855, fifteen years ago. I have not been able to get accounts of the yield of ore obtained by the late proprietor, Mr. Vaughan, and his immediate successors; but the Mynyddu Company, as at present constituted, have raised, since the year 1861, 422,000 tons, irrespective of its neighbour, the Bute hematite mine, on the west; and the Mynyddu alone has probably yielded since 1855 not less than half a million tons of ore. As to the future of the mine, I can only say it will probably continue to be worked for a long time to come. At first, near the surface, the ore conformed to the dip of the limestone—that is, a dip of about 35° from the horizontal, northwards, and was worked by open cutting, as may be seen; but latterly it has fallen more or less vertically into the limestone, and is now worked by underground mining. The vertical depth of the mine is 47 fathoms. Some of the ore is very hard, and requires blasting with powder or gun-cotton; while other parts are soft enough to be worked by the pick. In winter the water is very abun-

dant. After heavy rains we have to pump not less than 2300 gallons per minute. The ore is brought to surface by vertical shafts and inclined planes, and is taken by the broad and narrow gauge system of railway direct from the mines to the ironworks.

COLORADO—ITS MINERAL RESOURCES—No. II.

In my introduction to what I have to say on this subject I proposed before going into the merits of Colorado to touch upon its hypothetical demerits, and to answer some such objection as this:—"Well, if Colorado is such a superlatively rich country as you state, why has it not out-California'd California in the ten years of existence it has already enjoyed?" And, by way of such response, to give some account of the various causes which have militated against the full and complete development that a western gold country decade would seem to imply.

I say full and complete—and use this qualification from the standpoint of the Western way of thinking—for few Europeans going to Colorado now—and seeing all its signs of progress, if not of maturity, would be inclined to depreciate the pace of its ten years of existence, or the quality and quantity of their practical results.

In 1860, for the people of Jefferson Territory (which, I think, was the nursery name of Colorado) the year opened on a bright and hopeful future. They had proved that the mines were rich and wide—they had passed through a winter (in the Rocky Mountains!) that astonished them with its mildness and geniality. Since the September and October of the preceding year arrastras and steam quartz mills had been running; and though the surface gossan had shown signs of being exhausted, and giving place to a more solid and difficult material, yet this paid well, and improved in value the deeper it went. Tunnels—eleven altogether—were being driven in the Central City district, though it is true that, being situated too near the surface from want of capital, they proved eventually to be so much money thrown away. Roads were in existence already, two into the mountains, due west of Denver—one into the South Park had been constructed during the winter, and fair trails in many directions exhibited the rudiments of the roads of the present. The winter had been spent in prospecting, and had added its contribution of rich discoveries. And now they were to have henceforth—in addition to the wealth that, in spite of every obstacle, had shown itself in such force the year before—supplies, communications, machinery, implements, law, order, civilisation, and all its blessings, and fuller benefits from the agricultural capacities of their country, which had come upon them as a surprise, and a gospel too good to be true.

In April and May (the worst months in Colorado) a steady tide of immigration set in. By May 1, 11,000 wagons were computed to have passed Plum Creek; and the capitulation rate of new comers from the States was 100 a day. But, in proportion to the expense of living, wages were very low, or, at all events, not much higher than at home (in the States). The inevitable disappointment of the many ensued, and by June 1 a tide of emigration turned back, not strong enough, however, to outbalance the constant influx of fortune-seekers, who kept arriving for two months more at an average rate of 5000 men a week. The quartz mills kept on multiplying, and gave a good deal of employment. On July 1 Gregory district had 60 mills and 30 arrastras, the latter being much more successful, as a general thing, than the stamps. A contemporary writer says, for instance, "Some of the mills have tried quartz from the 'Bates,' and pronounced it worthless, while the arrastras got \$200 a cord from the same stuff." And so it has been ever since. As a final process, the stamp-mill has been found seriously wanting. Good authorities think that the extraction of 20 or 30 per cent. of the bullion existing in the matrix is above their average performance.

The design of these remarks excludes from notice the placer mining, which occupied the bulk of the miners at this period. Their average production was, perhaps, some \$5 a day to the hand, though this estimate is rather over the mark. Placer mining and its congeners—bar, gulch, and patch diggings—are, from their *raison d'être*, all ephemeral; while, on the other hand, quartz mining is, or judiciously conducted ought to be, one of the most permanent occupations of mankind.

The next year (1861) the immigration was very limited, and the country advanced slowly but surely; good Colorado fashion, grumbling almost as much as Englishmen; complaint of hard times and steady improvement going hand in hand. About now began the era of novel processes—chemical baths, superheated steam, heaven knows what of novelty was not tried and found wanting; and, of course, some improvements resulted from the increase of experience, the teachings of foreign (chiefly German) metallurgists, and last, not least, from native ingenuity.

The year 1862 was like enough to its predecessor in most respects. Some specimens of the mill yields may be interesting. In this year—Holman and Co.'s mill from Freeland 40 tons of rock took \$1032.00 Williams and Co., from Orphan Boy 70 tons of rock took \$4512.00 Western mill, from Illinois 38 tons of rock took \$1032.00 Sablin and Grover, from Black 40 tons of rock took \$1148.00 Hayes and Kinkhead, from Gregory 35 tons of rock took \$1380.20 Hayes and Kinkhead, from Bates 60 tons of rock took \$1306.80 Hayes and Kinkhead, Gregory Extension 85 tons of rock took \$2326.60

Considering all the circumstances, it is doubtful whether any other mining country can be credited with superior results.

The gold quartz of California, as a matter of fact and experience, becomes stronger in quality and quantity as the veins go down; and though we find in Colorado no deeper mines at present than some 700 feet, yet everything goes to prove that they improve the deeper they are mined.

A claim (No. 2 east) on the Bob Tail Mine is a good instance in point: 6 feet below the grass roots a decomposed quartz was struck; with a 4-foot crevice, paying some \$40 a ton; this continued downward for 39 feet, when a horse (or cap as it is called in Colorado) occurred, which averaged some \$12 a ton, and extended 26 ft.; then the crevice was struck again, 3 1/2 feet wide, yielding \$38 a ton, and extending 70 feet down. Here a second cap averaged \$15 a ton, and was 35 feet thick; then, for another 40 feet, a 3-foot crevice, worth \$60 a ton. Then another cap, of 50 feet, worth \$42 a ton. Shortly after this epoch in the history of the claim, circumstances independent of the mine stopped its working; but it is a very good average specimen of a Colorado mine, subject to be pinched up in caps, and requiring capital to drive the working through them to reach the good pay crevice again, but always improving in richness, cap for cap, and crevice for crevice, and hitherto these veins—true fissure veins—have never in a single instance given out or been exhausted.

We have now come to the year 1863—the year of inflation and collapse in our history. The bankers in the eastern cities—New York, Boston, Philadelphia—had for some time been connected with sundry Colorado mines; they had received gold from them, and were prepared, when occasion offered, to take them off the hands of the non-moneyed class which owned them. These very mines had been easy to work on the surface; the gold was free in the oxidised vein materials; no drainage difficulties had occurred yet; money was easily got, and more easily spent. But when the times changed, and deeper mines required draining, and cost more for hoisting, fuel got scarcer, and the ores themselves became refractory and difficult to treat, the miners, as was natural, became embarrassed. The Eastern men advanced money on the mines at first, and then, by a not uncommon process, became the owners of them. And having acquired this property cheaply, proceeded to organise companies to purchase them dearly. In the mining countries which were the subject of these operations of course steady work was killed by this sort of thing, and everyone wanted to do likewise, and become suddenly rich. The bubble sailed gaily about in this sunshine very iridescent and pretty for some six months, and then, in the spring of 1864, miserably collapsed. The companies that went to work, and with ample capital, were sufferers from the very excitement that gave them birth; all expenses of labour and living became inflated to—aye, a 100 per cent. in excess of former times, and, indeed, have only subsided in obedience to the railway whistle of the present year.

There has been a great outcry made about "refractory ores," and the fact of Colorado gold and silver being, as it is, at a short distance from the surface, very generally sulphurets, and in combinations which present considerable difficulties to their successful exploitation, is no doubt a serious matter in the early days of doubt and inexperience, and it has been assailed by a legion of ingenious novelties with little avail; for, after a long time of waiting and hoping, the com-

mon consent is to fall back on smelting, and the old-established processes of this treatment, as the best plan. But now, with railroad transport to the Atlantic, even supposing that New Jersey had no Swansea of its own, and America no skilful metallurgists, such is the average richness of the minerals that the crude ore might be transported to Swansea itself and leave a fair margin of profit. This, of course, will never happen as a general thing, but it goes to demonstrate the improvement which has taken place in this region since the year 1864. At that time, in mid-continent, thousands of miles from either sea, some 700 miles from any base of supplies with an agricultural country till then reputed a Sahara, a desert—hardly daring to believe it the marvel of virgin fertility it has been since proved to be; with this country in its earliest and tentative crops devoured by the grasshoppers, lingering over their fast vanishing domains, and reluctantly relinquishing, as such things do in new countries, their hold on what civilisation was surely taking to herself; with all supplies, and tools, and implements tariffed in the matter of transport with 6d. per lb. weight, with the steady drain upon Western resources caused by the civil war, prices of raw material of all kinds inflated; labour, that ought to have been productive, with a musket in its hand consuming itself, and other like labour, and salt-petre. Then, the Government having omitted to lay on adequate taxation for war expenses, the currency was, of course, depreciated, as everybody knows. Then, in the summer of 1863, accident added to this Pelion of agony piled upon an agonised Ossa—an universal drought dried up the West, scorched the Platte and even the Missouri into uselessness, and burned up the feed upon the plains. Upon this succeeded a winter (1863-64) earlier and bitter than any in the memory of the young territory. Trains of supplies were imprisoned by the snow, and cattle frozen by the thousand on the plains. Of course, prices of everything advanced, and retrograded equally, of course, very reluctantly long after the need was over.

About this time it was that the Eastern men went to work with the Colorado mines. They went wrong from the first; set up vast plants of machinery and gigantic establishments, totally disproportionate to the mines and the period. And, moreover, the stamp-mill was selected as the engine of production. As I noticed, about 25 per cent. of the gold, and a total loss of the silver and copper (often worth quite as much as the gold) of the rock, is all that the most efficient stamp-mill does. Here, again, Nature and accident stepped in to do their worst. It was a bad time for speedy execution of orders in the iron-foundries and machine-shops of the then dis-United States. War material was as much as they could be reckoned on for. Then, when these delays were partly surmounted, the weather in the spring of 1864 was exceptional. The windows of the upper deeps opened upon the unlucky country—towns, farms, and crops were swept away by floods, and the mines themselves refused to harbour the industry that had opened them. Transportation on the plains was seriously retarded, and when the weather permitted its resumption the Indians rose, by concerted action, all over the plains, and destroyed the communications for two months at the most important part of the year. Youthful Colorado had already equipped and sent away two regiments of two battalions each for the war, and now 1200 more men were taken away to chastise the Indians (and the results of the solitary action of this "three-months'-men" organisation had the practical effect of protracting the Indian trouble, and cutting off communication in the next winter).

All this adverse fortune advanced prices of everything—freight, labour, living. The funds of the several companies were exhausted by useless expenditure before their disproportionate machinery arrived, or even, much less could it be advantageously used. American stockholders like early dividends, and do not like paying calls. A good deal of the property of many of them was simply "wild-cat;" that of others consisted of scattered fragments of mining property, lung heterogeneous over a whole township, and the capital in many cases of these companies had been watered to such an extent as to restrict all possibility of profit from them to their several promoters. Delusive hopes had been dishonestly raised. Most unit representatives of the interests of mining companies were sent out—scapegrace relations, and men unsuited in every way for any responsible function. And, to compound the worst of this confusion, the directors attempted to copy the War Office of the period, and to manage mining by telegraph from Boston to New York! Nothing but disaster could come from this, and nothing else did.

TESTING METALS MECHANICALLY.

An improved apparatus for testing the quality of the malleable metals and alloys, designed by Mr. GUSTAV BISCHOFF, of Bonn, has been introduced by Messrs. Gething, Caro, and Co., of Newcastle-on-Tyne. It consists of minute models of rolling and of slitting mills for making test-strips. Mr. Bischoff objects to chemical analysis, because it only shows the absence or presence of impurities, without being able to state their exact deteriorating effect, and claims that his method indicates either the absence of impurities, if the test-marks of metals or alloys rise to the standard of pure metal or alloy, or the deteriorating effect of impurities without giving their names. In testing the qualities of metals or alloys, Mr. Bischoff distinguishes between such as do not materially alter in quality through fusion—zinc, tin, &c.; and such as do alter in quality—copper, brass, &c. The former he casts into ingots 120 mm. x 13 mm. x 3 mm (about 4 3/4 inches long, 1/2 inch wide, and 3/8 inch thick), which are rolled at the ordinary temperature into test strips, 130 mm. long, and 7 mm. wide, weighing for zinc and tin 1500 milligrammes, and for lead 2500 milligrammes. These test-strips are then annealed, and, finally, each is cut into two lengths, 65 mm. long, when they are ready for testing in the metallometer. In the case of copper, brass, or other metals or alloys which alter in quality through fusion, one must again distinguish whether plates or ingots are to be tested; from plates strips are taken in the direction in which the plate has passed through the rolls, from ingots the strip is sawed or chiselled out. They are rolled down, as in the case of zinc, and cut into similar-sized test-strips, weighing for zinc and tin 1500 milligrammes, and for lead 2500 milligrammes. The annealing must also be effected under the same conditions if different samples of the same metal or alloy are to be compared.

The metallometer is described as containing two essential parts—a vice for fixing the test-strips, and a guide through which the strips pass. The guide is capable of turning upon two axes, which rest in bearings fixed to the vice. Weights keep the guide in a vertical position below the vice if the vice be moved by the movement on the axle to which it is fixed, and which rests on bearings in suitable standards. Thus, the guide forms an angle with the vice at each to-and-fro movement, and a test-strip, which is held suspended from the vice, and passes through the guide, will also, after the apparatus is set in motion, be bent alternately to the right and left, by preference to an angle of 67 1/2°, until it breaks, whereupon the part severed is caused to fall off, by means of a small weight attached to it. The metallometer is actuated preferably by clockwork, and the clockwork or mechanism which actuates the apparatus has two dial-plates, with pointers, which mark the number of to-and-fro movements the sample had withstood before breaking off—this number he terms the test-mark. For testing the particular strips the several apparatus appear to be very simple and ingenious, nothing being required to enable an approximate conclusion being arrived at as to the character of the plate or ingot tested, but a careful estimate of the change which the metal undergoes by the additional manipulation it receives in the test-rolling-machine employed to obtain the test-strip. The tables show some curious results—thus, 3 per cent. of lead as an impurity in zinc gives the same test-mark as zinc contaminated with one 100,000th of 1 per cent. of tin, and there are equally curious points in connection with other alloys. Mr. Bischoff points out how easily chemical analysis may mislead if exclusively relied upon, and maintains from experiments which he has made that the test-mark of a metal or alloy may be considered the result of its tenacity and toughness, as also of its malleability and softness, and that thus the commercial value of the metal can be easily ascertained.

PUDDLING MACHINERY.—In order to work the rabble or rake over the bed of the furnace in the manner in which a puddler works it by hand, Messrs. B. WALKER and J. F. A. PFLAUM, Leeds, employ hydraulic engines, or engines worked by water or liquid under high pressure, and which may be supplied from an accumulator or vessel furnished with a weighted ram, into which water or liquid is forced by pumps or other suitable instruments. On a standard rising above the furnace they mount an hydraulic engine or engine, and by means thereof they give motion to a bar swinging on an axis at the top of the standard, and at its lower end connected with the rabble or rake. In this way the motion into and out of the furnace is obtained.

MANUFACTURE OF GAS.—Mr. J. B. HICKMOTT, Carlisle, proposes to construct in the sides of the retort or generator a number of vertical channels or flues, communicating with the interior of the retort or generator by means of narrow vertical slits or openings, which, by reason of their small dimensions will not admit of any appreciable quantity of coal into the channels or flues, but readily allow the gas as it generates to pass into the said channels or flues, and thence into the vacant space in the top of the retort above the coal, whence it will be conveyed in the usual manner by means of a pipe to the condensing apparatus.

LONDON GENERAL OMNIBUS COMPANY.—The traffic receipts for the week ending December 11 were 88851. 2s. 11d.

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